

The JS 44 civil cover sheet and the information contained herein neither replace nor supplement the filing and service of pleadings or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet. (SEE INSTRUCTIONS ON NEXT PAGE OF THIS FORM.)

I. (a) PLAINTIFFS

AVOGET SPORTS TECHNOLOGY, INC.

(b) County of Residence of First Listed **SAN MATEO**

(EXCEPT IN U.S. PLAINTIFF CASES)

(c) Attorneys (Firm Name, Address, and Telephone Number)

Frear Stephen Schmid, CSB No. 96089, Attorney at Law, 177 Post Street, Suite 890, San Francisco, CA 94108, Tel: (415) 788-5957

DEFENDANTS

POLAR ELECTRO, INC. 14

County of Residence of First Listed Defendant

(IN U.S. PLAINTIFF CASES ONLY)

NOTE:

IN LAND CONDEMNATION CASES, USE THE LOCATION OF THE TRACT OF LAND INVOLVED.

Attorneys (If Known)

John P. Moran, Esq., Holland and Knight, LLP, 2099 Pennsylvania Avenue, N.W., Suite 100, Washington, D. 20006, Tel: (202) 955-3000

II. BASIS OF JURISDICTION (Place an "X" in One Box Only)

- ☐ 1 U.S. Government Plaintiff
- ☒ 3 Federal Question (U.S. Government Not a Party)
- ☐ 2 U.S. Government Defendant
- ☐ 4 Diversity (Indicate Citizenship of Parties in Item III)

III. CITIZENSHIP OF PRINCIPAL PARTIES (Place an "X" in One Box for Plaintiff and One Box for Defendant)

- | | PTF | DEF | | PTF | DEF |
|---|----------------------------|----------------------------|---|----------------------------|----------------------------|
| Citizen of This State | <input type="checkbox"/> 1 | <input type="checkbox"/> 1 | Incorporated or Principal Place of Business In This State | <input type="checkbox"/> 4 | <input type="checkbox"/> 4 |
| Citizen of Another State | <input type="checkbox"/> 2 | <input type="checkbox"/> 2 | Incorporated and Principal Place of Business In Another State | <input type="checkbox"/> 5 | <input type="checkbox"/> 5 |
| Citizen or Subject of a Foreign Country | <input type="checkbox"/> 3 | <input type="checkbox"/> 3 | Foreign Nation | <input type="checkbox"/> 6 | <input type="checkbox"/> 6 |

IV. NATURE OF SUIT (Place an "X" in One Box Only)

CONTRACT	TORTS	FORFEITURE/PENALTY	BANKRUPTCY	OTHER STATUTES	
<input type="checkbox"/> 110 Insurance <input type="checkbox"/> 120 Marine <input type="checkbox"/> 130 Miller Act <input type="checkbox"/> 140 Negotiable Instrument <input type="checkbox"/> 150 Recovery of Overpayment & Enforcement of Judgment <input type="checkbox"/> 151 Medicare Act <input type="checkbox"/> 152 Recovery of Defaulted Student Loans (Excl. Veterans) <input type="checkbox"/> 153 Recovery of Overpayment of Veteran's Benefits <input type="checkbox"/> 160 Stockholders' Suits <input type="checkbox"/> 190 Other Contract <input type="checkbox"/> 195 Contract Product Liability <input type="checkbox"/> 196 Franchise	PERSONAL INJURY <input type="checkbox"/> 310 Airplane <input type="checkbox"/> 315 Airplane Product Liability <input type="checkbox"/> 320 Assault, Libel & Slander <input type="checkbox"/> 330 Federal Employers' Liability <input type="checkbox"/> 340 Marine <input type="checkbox"/> 345 Marine Product Liability <input type="checkbox"/> 350 Motor Vehicle <input type="checkbox"/> 355 Motor Vehicle Product Liability <input type="checkbox"/> 360 Other Personal Injury <input type="checkbox"/> 362 Personal Injury - Med. Malpractice	PERSONAL INJURY <input type="checkbox"/> 365 Personal Injury - Product Liability <input type="checkbox"/> 367 Health Care/Pharmaceutical Personal Injury Product Liability <input type="checkbox"/> 368 Asbestos Personal Injury Product Liability PERSONAL PROPERTY <input type="checkbox"/> 370 Other Fraud <input type="checkbox"/> 371 Truth in Lending <input type="checkbox"/> 380 Other Personal Property Damage <input type="checkbox"/> 385 Property Damage Product Liability	<input type="checkbox"/> 625 Drug Related Seizure of Property 21 USC 881 <input type="checkbox"/> 690 Other LABOR <input type="checkbox"/> 710 Fair Labor Standards Act <input type="checkbox"/> 720 Labor/Mgmt. Relations <input type="checkbox"/> 740 Railway Labor Act <input type="checkbox"/> 751 Family and Medical Leave Act <input type="checkbox"/> 790 Other Labor Litigation <input type="checkbox"/> 791 Empl. Ret. Inc. Security Act IMMIGRATION <input type="checkbox"/> 462 Naturalization Application <input type="checkbox"/> 463 Habeas Corpus - Alien Detainee (Prisoner Petition) <input type="checkbox"/> 465 Other Immigration Actions	<input type="checkbox"/> 422 Appeal 28 USC 158 <input type="checkbox"/> 423 Withdrawal 28 USC 157 PROPERTY RIGHTS <input type="checkbox"/> 820 Copyrights <input checked="" type="checkbox"/> 830 Patent <input type="checkbox"/> 840 Trademark SOCIAL SECURITY <input type="checkbox"/> 861 MIA (1395ff) <input type="checkbox"/> 862 Black Lung (923) <input type="checkbox"/> 863 DIWC/DIWW (405(g)) <input type="checkbox"/> 864 SSID Title XVI <input type="checkbox"/> 865 RSI (405(g)) FEDERAL TAX SUITS <input type="checkbox"/> 870 Taxes (U.S. Plaintiff or Defendant) <input type="checkbox"/> 871 IRS—Third Party 26 USC 7609	<input type="checkbox"/> 375 False Claims Act <input type="checkbox"/> 400 State Reapportionment <input type="checkbox"/> 410 Antitrust <input type="checkbox"/> 430 Banks and Banking <input type="checkbox"/> 450 Commerce <input type="checkbox"/> 460 Deportation <input type="checkbox"/> 470 Racketeer Influenced and Corrupt Organizations <input type="checkbox"/> 480 Consumer Credit <input type="checkbox"/> 490 Cable/Sat TV <input type="checkbox"/> 850 Securities/Commodities/Exchange <input type="checkbox"/> 890 Other Statutory Actions <input type="checkbox"/> 891 Agricultural Acts <input type="checkbox"/> 893 Environmental Matters <input type="checkbox"/> 895 Freedom of Information Act <input type="checkbox"/> 896 Arbitration <input type="checkbox"/> 899 Administrative Procedure Act/Review or Appeal of Agency Decision <input type="checkbox"/> 950 Constitutionality of State Statutes
REAL PROPERTY <input type="checkbox"/> 210 Land Condemnation <input type="checkbox"/> 220 Foreclosure <input type="checkbox"/> 230 Rent Lease & Ejectment <input type="checkbox"/> 240 Torts to Land <input type="checkbox"/> 245 Tort Product Liability <input type="checkbox"/> 290 All Other Real Property	CIVIL RIGHTS <input type="checkbox"/> 440 Other Civil Rights <input type="checkbox"/> 441 Voting <input type="checkbox"/> 442 Employment <input type="checkbox"/> 443 Housing/Accommodations <input type="checkbox"/> 445 Amer. w/Disabilities - Employment <input type="checkbox"/> 446 Amer. w/Disabilities - Other <input type="checkbox"/> 448 Education	PRISONER PETITIONS <input type="checkbox"/> 510 Motions to Vacate Sentence Habeas Corpus: <input type="checkbox"/> 530 General <input type="checkbox"/> 535 Death Penalty <input type="checkbox"/> 540 Mandamus & Other <input type="checkbox"/> 550 Civil Rights <input type="checkbox"/> 555 Prison Condition <input type="checkbox"/> 560 Civil Detainee - Conditions of Confinement			

V. ORIGIN

(Place an "X" in One Box Only)

- ☒ 1 Original Proceeding
- ☐ 2 Removed from State Court
- ☐ 3 Remanded from Appellate Court
- ☐ 4 Reinstated or Reopened
- ☐ 5 Transferred from another district (specify)
- ☐ 6 Multidistrict Litigation

VI. CAUSE OF ACTION

Cite the U.S. Civil Statute under which you are filing (Do not cite jurisdictional statutes unless diversity):

35 U.S.C. Section 282

Brief description of cause:

Patent infringement

VII. REQUESTED IN COMPLAINT:
☐ CHECK IF THIS IS A CLASS ACTION UNDER F.R.C.P. 23

DEMAND \$ Per Proof

CHECK YES only if demanded in complaint:

JURY DEMAND: ☒ Yes ☐ No**VIII. RELATED CASE(S) IF ANY**

(See instructions):

JUDGE

Honorable James Ware

DOCKET NUMBER 3:11-cv-04049-JW

IX. DIVISIONAL ASSIGNMENT (Civil L.R. 3-2)

(Place an "X" in One Box Only)

☒ SAN FRANCISCO/OAKLAND☐ SAN JOSE☐ EUREKA

DATE May 3, 2012

SIGNATURE OF ATTORNEY OF RECORD

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8 AVOCET SPORTS TECHNOLOGY, INC.

FILED
2012 MAY -4 A 9 24 E-filing
RICHARD W. WIEKING
CLERK, U.S. DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA

9 UNITED STATES DISTRICT COURT
10 NORTHERN DISTRICT OF CALIFORNIA
11 SAN FRANCISCO DIVISION

CV 12 2234

JSC

12 AVOCET SPORTS TECHNOLOGY,
13 INC.,

No.

14 Plaintiff,

COMPLAINT FOR PATENT
INFRINGEMENT
[JURY TRIAL DEMANDED]

15 v.

16 POLAR ELECTRO, INC.,

17 Defendant.

18 Plaintiff AVOCET SPORTS TECHNOLOGY, INC. ("Avocet") files this Complaint
19 for patent infringement against defendant POLAR ELECTRO, INC. ("Polar").

20 CLAIM FOR PATENT INFRINGEMENT

21 JURISDICTION

22 1. Jurisdiction is pursuant to 28 U.S.C. § 1338, allowing original jurisdiction
23 in this court for patent cases.

24 VENUE

25 2. Venue is proper in this judicial district pursuant to 28 U.S.C. § 1391(c) in
26 that defendant, Polar Electro, Inc., is subject to personal jurisdiction in this district as
27 defendant regularly transacts and transacted business here.

28 INTRADISTRICT ASSIGNMENT

3. Because this case is an Intellectual Property Action, it is not subject to

1 assignment to a particular location or division of the Court under Local Rule 3-2(c).

2 **NATURE OF THE ACTION**

3 4. This is an action brought against defendant for the past infringement of
4 the United States Patent No. 5,058,427, Claims 17-20, inclusive ("the '427 Patent"),
5 methods for selectively accumulating altitude changes.

6 5. On October 22, 1991, United States Patent No. 5,058,427 was duly and
7 legally issued and its current assignee is plaintiff Avocet Sports Technologies, Inc.. A
8 true and correct copy of the patent, as duly assigned, is attached hereto as Exhibit 1
9 and is incorporated herein by reference. Said patent pertains to accumulating
10 altimeters as more extensively and precisely described in the attached patent.

11 **FACTUAL BACKGROUND**

12 **I. THE ASSERTED '427 PATENT**

13 6. At all times relevant, Avocet is and was the owner of the '427 Patent and
14 has and had the rights thereunder. Through years of marketing and sales, plaintiff's
15 patent was well known to each defendant at all times relevant hereto.

16 **II. POLAR'S INFRINGEMENT OF THE '427 PATENT**

17 **A. THE POLAR ACCUSED PRODUCTS**

18 7. Polar tested, demonstrated, provided instructions for, provided training for,
19 marketed, made, used, offered to sell, sold, and/or imported into the United States
20 devices that contain an accumulating altimeter that includes a programmable
21 accumulator which selectively accumulates altitude changes from a reference altitude in
22 accordance with accumulation thresholds as taught by the '427 patent. The model
23 name/numbers of the Polar altitude devices include, without limitation, Polar Model
24 Name/Numbers S625X, S725X, RS800CX, RS800CX Bike, RS800CX Multi, RS800CX
25 Run, CS400, CS500, CS500 tour de france, CS600, CS600X, AXN300, AXN500,
26 AXN700.

27 **B. POLAR'S DIRECT INFRINGEMENT OF THE '427 PATENT**

28 8. During the period commencing August 18, 2005, and ending upon the

1 expiration of the '427 Patent, Polar directly infringed one or more of the Method Claims
2 of the '427 Patent under 35 U.S.C. § 271(a) because it has used, tested, and/or
3 demonstrated the altitude accumulator aspects of the Polar Devices by using one or
4 more of plaintiff's Method Claims. In order to have used, tested, and/or demonstrated
5 the altitude accumulator aspect of the Polar Devices, Polar had to utilize one or more of
6 plaintiff's Method Claims of the '427 Patent. Polar could not have implemented the
7 accumulating altitude change features of the Polar Devices without infringing the
8 Method Claims of the '427 Patent.

9 **C. POLAR'S INDUCED INFRINGEMENT OF THE '427 PATENT**

10 9. Polar is liable for indirect infringement under 35 U.S.C. §271(b) because it
11 has knowingly induced the direct infringement of one or more of the Method Claims of
12 the '427 Patent by end-users and other third parties.

13 **1. METHOD CLAIMS**

14 **a. Underlying Direct Infringement by End-Users and**
15 **Third Parties**

16 10. During the period commencing August 18, 2005, and ending upon the
17 expiration of the '427 Patent, end-users and other third parties directly infringed one or
18 more of the Method Claims of the '427 Patent by using the Polar devices.

19 **b. Active Steps to Induce Infringement**

20 11. During said time period, Polar knowingly took active steps to induce end-
21 users and other third parties in the United States to engage in direct infringement of the
22 Method Claims of the '427 Patent. For example, Polar provided, sold, or promoted the
23 Polar Devices to end-users or other third parties along with specific instructions or
24 training regarding the use of those devices, which instructions or training actively
25 induced said end-users and other third parties to practice the '427 Patent Method
26 Claims and said instructions or training caused direct infringement of the '427 Patent
27 Method Claims.

28 ///

c. **Specific Intent to Induce Infringement**

12. During said time period, Polar possessed the specific intent to induce infringement of the Method Claims of the '427 Patent by end-users and other third parties which intent was manifested, inter alia, by its instructions or training for using the Polar devices.

13. During said time period, Polar had knowledge of the '427 Patent and knowledge that the use of the Polar Devices per its instructions and/or training infringed the Method Claims of the '427 Patent. In addition, during said time period, Polar knew or should have known that its actions would and did induce infringement of the Method Claims by end-users and other third party users. Polar had actual knowledge of the '427 Patent inter alia due to (1) its active participation and competition in the altimeter market, including but not limited to trade shows, where Polar discussed with plaintiff, saw, read, and observed plaintiff's patented accumulating altimeter devices and promotional materials, packaging and instruction pertaining thereto, all of which provided notice of and identified the subject '427 Patent, (2) Polar's altimeter market research, (3) Polar's research and development of the Polar devices, (4) Polar's numerous patents concerning altimeter devices, (5) Polar's patent searches, and prior art searches pertaining to patent applications and patent acquisition concerning inter alia altimeter devices, (6) Polar's exercise of due diligence pertaining to intellectual property purchase and acquisition, (7) Polar's involvement in litigation with PhatRat Technology, Inc. V. Polar Electro Inc and Polar Electro OY, e.g., Defendant's Polar Answer and Counterclaim in U.S. District Court, District of Colorado, action no. 06-cv-01100-WDM-PAC, and (8) personal meetings between Polar representatives and Bud Hoffacker, a principal of Avocet, concerning the subject patent and licensing thereof.

14. During said time period, Polar knew or should have known that testing, demonstrating, marketing, making, using, offering to sell, selling, and/or importing into the United States the Polar Devices constituted infringement of the Method Claims of the '427 Patent, based on, among other things, said participation in the altimeter market

1 in general, and as direct competition to plaintiff.


2 15. During said time period, Polar has knowingly taken active steps to induce
3 end-users and other third parties to engage in direct infringement of the Method Claims
4 of the '427 Patent and has done so with an affirmative intent to cause such direct
5 infringement and/or with purposeful, culpable expression and conduct to encourage
6 such direct infringement. Polar's specific intent to induce infringement is evidenced by,
7 among other things, Polar's providing of specific instructions and/or training to end-
8 users and/or other third parties knowing that its acts would induce end-users and other
9 third parties to use the Polar Devices and by so doing to directly infringe the Method
10 Claims of the '427 Patent.

11 16. As a result of Polar's infringement of plaintiff's '427 Patent as set forth
12 above, plaintiff is entitled to damages in an amount according to proof and because
13 Polar's infringement of the '427 Patent was wilful and deliberate and without a
14 reasonable basis for believing that its conduct was lawful, plaintiff is entitled to treble
15 damages under 35 U.S.C. § 284 and to attorney's fees and costs incurred in
16 prosecuting this action under 35 U.S.C. § 285.

17 **WHEREFORE** plaintiff demands judgment as follows:

- 18 1. That defendant render an accounting for all profits defendant received by
19 infringing said patent;
- 20 2. For damages against defendant sufficient to compensate plaintiff pursuant
21 to 35 U.S.C. § 284, in an amount according to proof.
- 22 3. For treble damages;
- 23 4. For costs and reasonable attorney fees of the subject litigation and
24 interest as allowable by law; and
- 25 5. For such other and further relief as the court may deem just and proper.

26 DATED: May 4, 2012

27 
28 Frear Stephen Schmid, Attorney for
Plaintiff AVOCET SPORTS
TECHNOLOGY, INC.

DEMAND FOR JURY TRIAL

Plaintiff hereby demands a jury trial pursuant to Federal Rules of Civil Procedure 38.

DATED: May 4, 2012


Frear Stephen Schmid, Attorney for
Plaintiff AVOCET SPORTS
TECHNOLOGY, INC.

EXHIBIT 1

United States Patent [19]

Brandt

[11] Patent Number: 5,058,427

[45] Date of Patent: Oct. 22, 1991

[54] ACCUMULATING ALTIMETER WITH
ASCENT/DESCENT ACCUMULATION
THRESHOLDS

4,969,358 11/1990 Peet, II 73/384
5,001,929 3/1991 Peet, II 73/384

FOREIGN PATENT DOCUMENTS

3638122 5/1988 Fed. Rep. of Germany 340/977

Primary Examiner—Donald O. Woodiel

Attorney, Agent, or Firm—Limbach, Limbach & Sutton

[75] Inventor: Jobst Brandt, Palo Alto, Calif.

[73] Assignee: Avocet, Inc., Menlo Park, Calif.

[21] Appl. No.: 590,472

[22] Filed: Sep. 28, 1990

[51] Int. Cl.³ G01C 21/20

[52] U.S. Cl. 73/384; 340/977;
364/433

[58] Field of Search: 73/384, 385, 386, 387;
364/433; 340/977, 432

References Cited

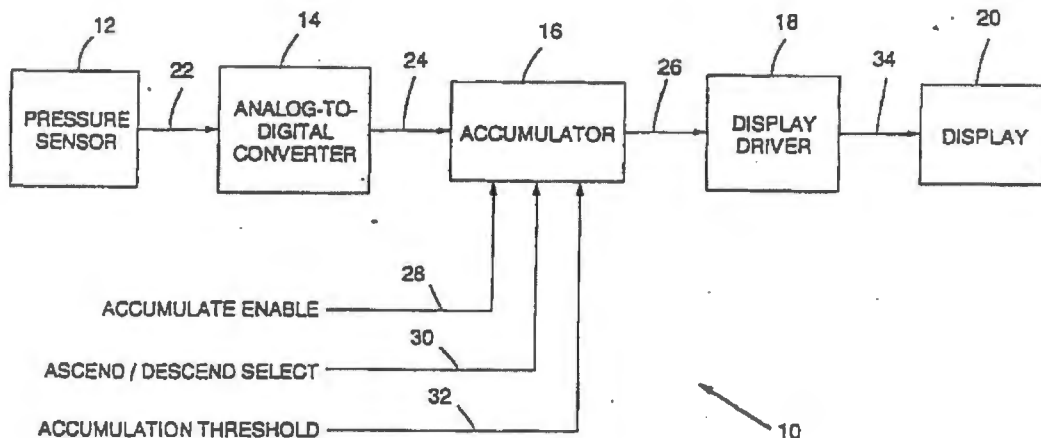
U.S. PATENT DOCUMENTS

3,958,108	5/1976	Shimomura	235/150,25
4,030,065	6/1977	Bateman	340/27
4,106,343	8/1978	Cook	73/387
4,257,112	3/1981	Hubner	368/11
4,279,028	7/1981	Lowdenslager et al.	368/11
4,292,671	9/1981	Evans et al.	364/433
4,507,962	4/1985	Hitt et al.	73/384
4,638,664	1/1987	Tamura	73/384
4,694,694	9/1987	Vlakancic et al.	73/386

[57] ABSTRACT

An accumulating altimeter includes a programmable accumulator which selectively accumulates altitude changes from a reference altitude in accordance with accumulation thresholds. Altitude changes in the direction of interest, e.g. altitude gains, are accumulated once a non-opposing accumulation threshold has been reached. Opposing altitude changes which are less than an opposing accumulation threshold are used to offset non-opposing changes. Opposing altitude changes which are equal to or greater than the opposing accumulation threshold are used to re-establish the reference altitude, whereafter accumulation of non-opposing altitude changes resume after the non-opposing accumulation threshold has been reached.

20 Claims, 5 Drawing Sheets



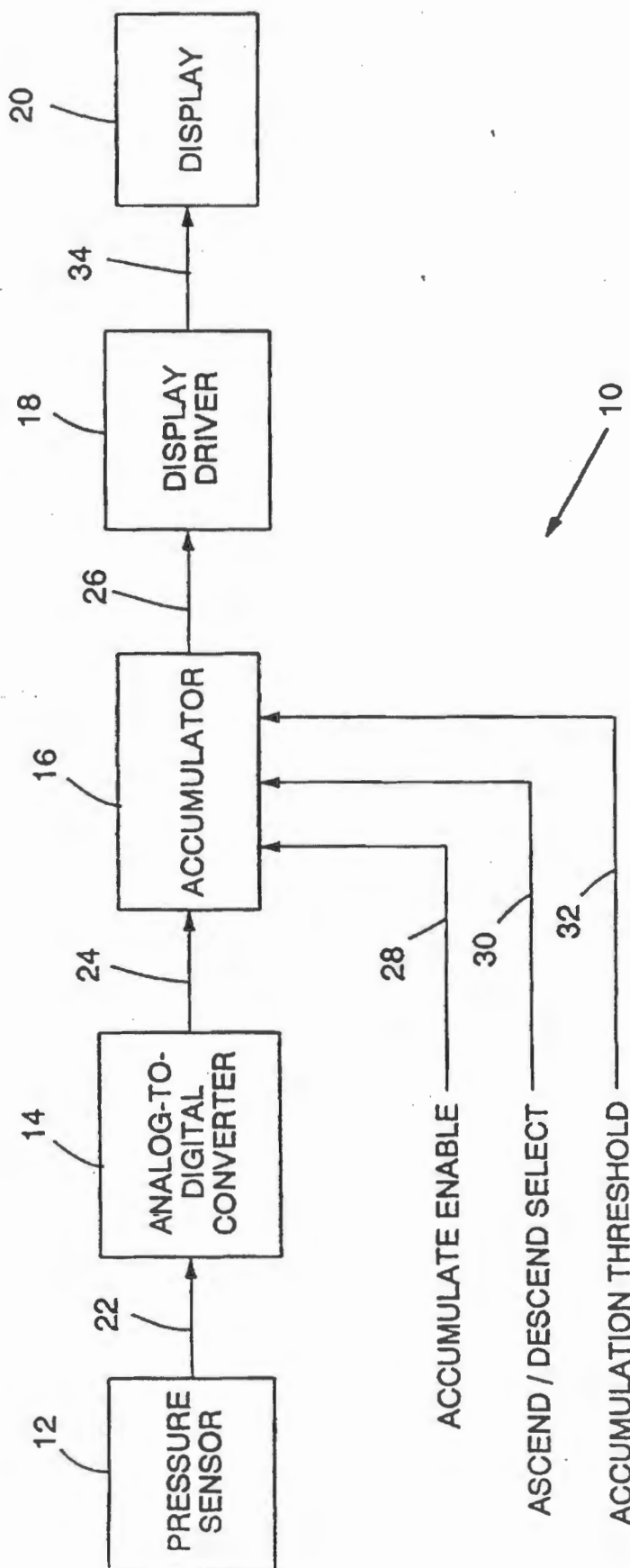


FIG. 1

U.S. Patent

Oct. 22, 1991

Sheet 2 of 5

5,058,427

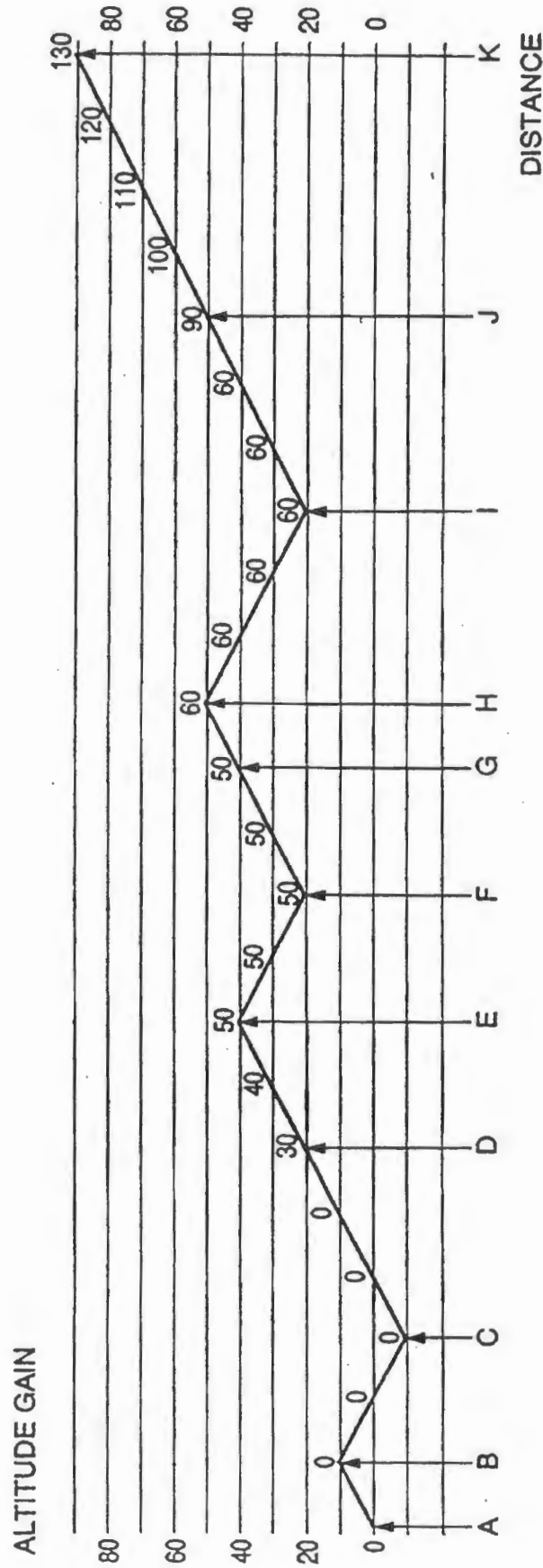


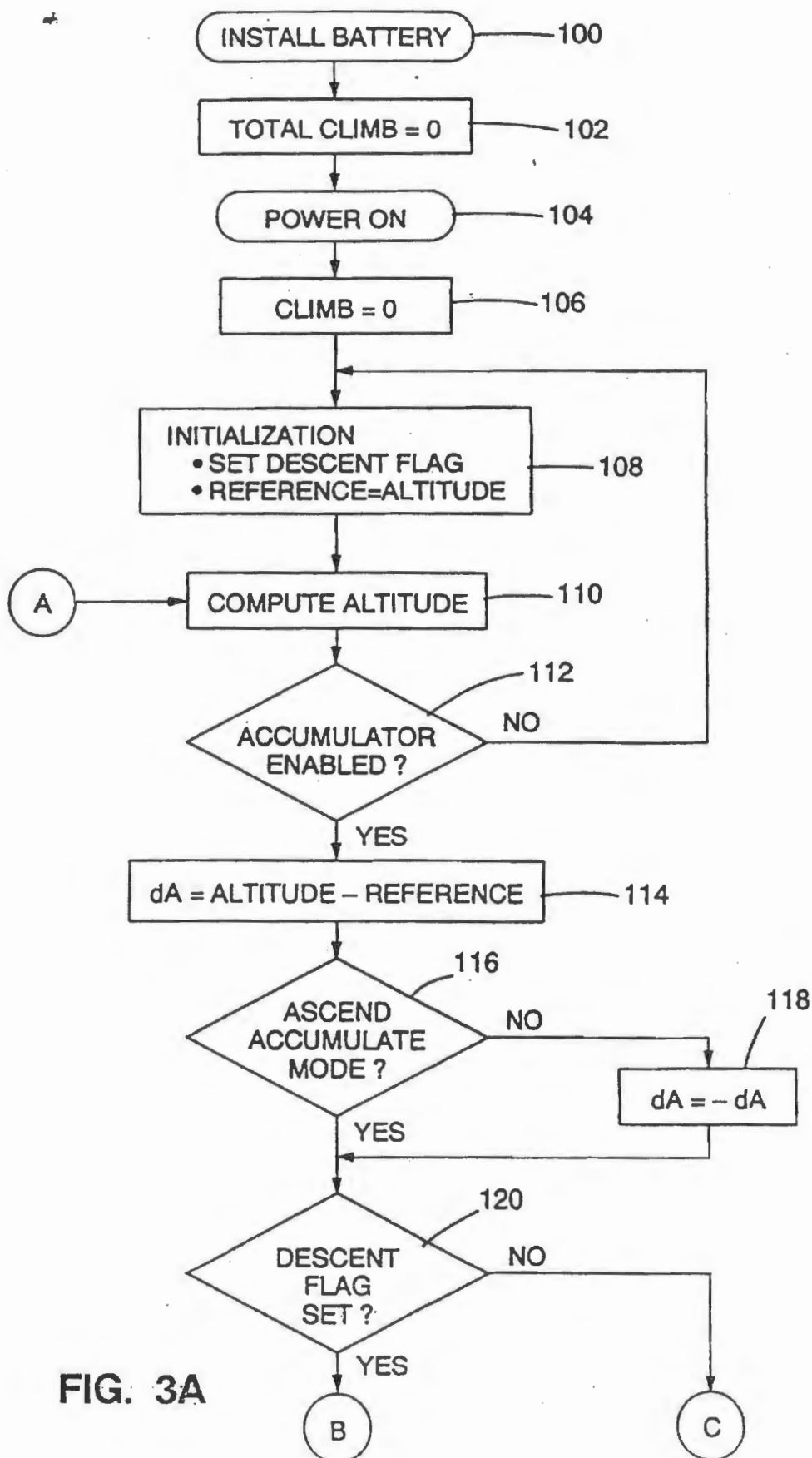
FIG. 2

U.S. Patent

Oct. 22, 1991

Sheet 3 of 5

5,058,427



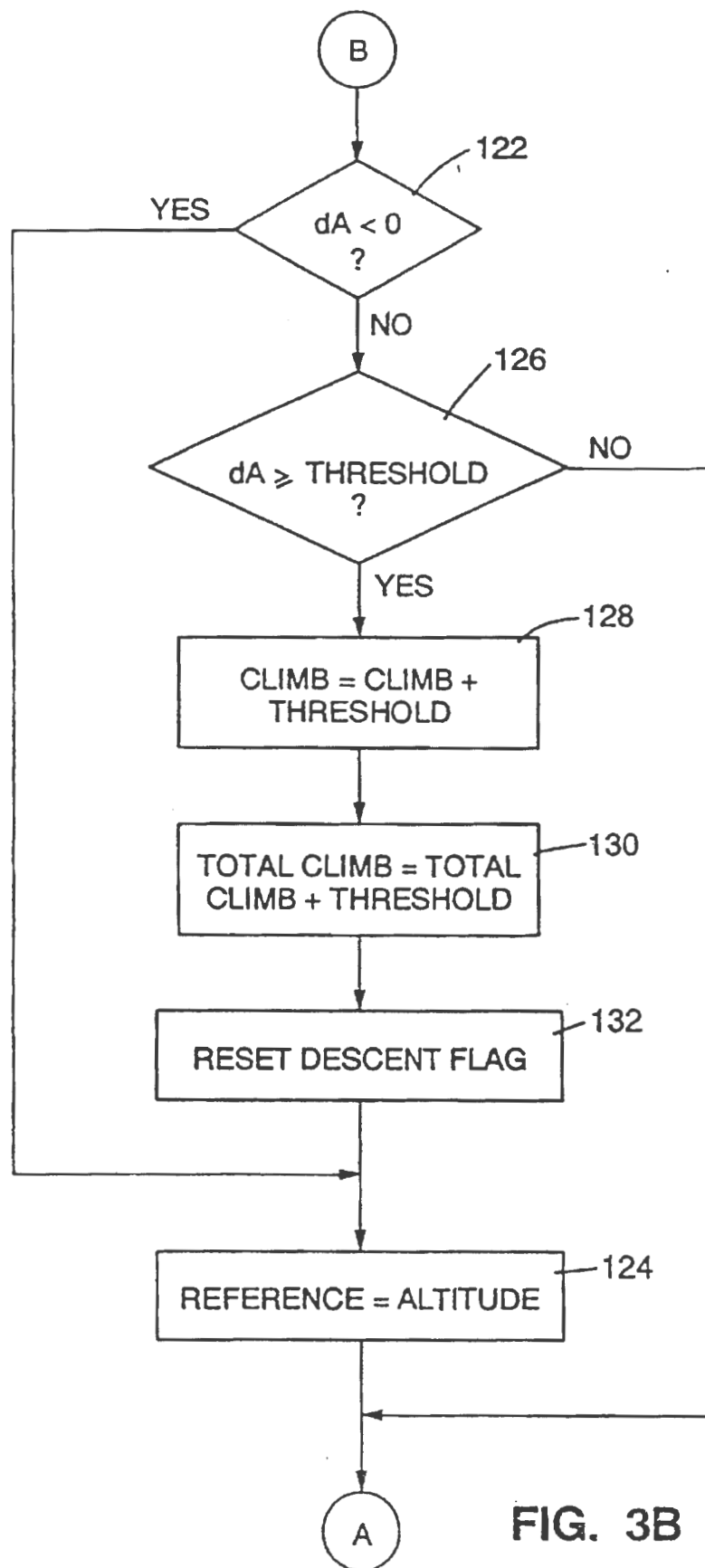


FIG. 3B

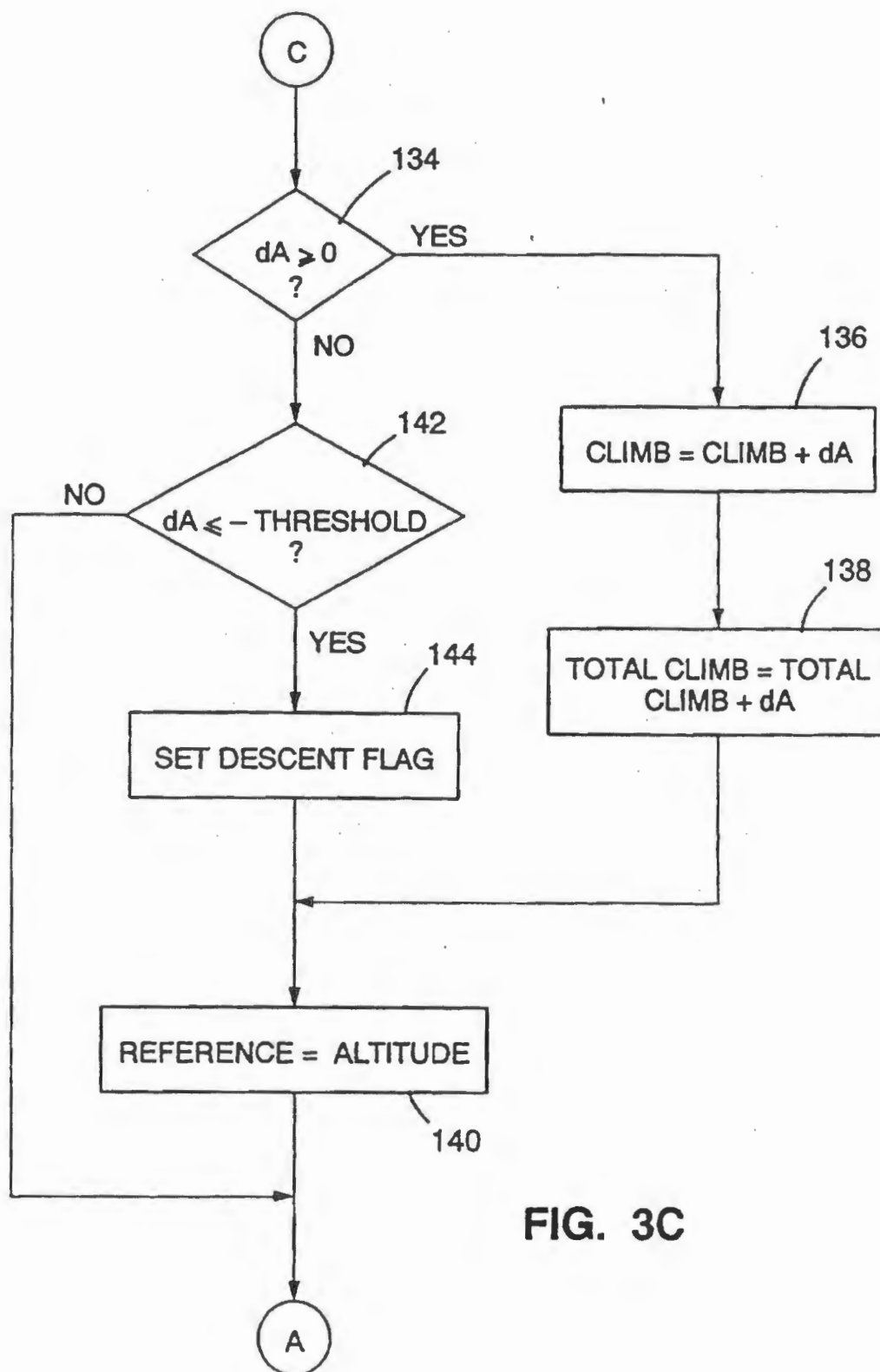


FIG. 3C

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ACCUMULATING ALTIMETER WITH ASCENT/DESCENT ACCUMULATION THRESHOLDS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to altimeters, and in particular, to accumulating altimeters which selectively accumulate total altitude gains or losses for ascents or descents, respectively, for a selected period of time.

2. Description of the Related Art

With the development of solid state altimeters, such as those using piezoelectric or piezoresistive elements, use of altimeters for various activities has grown. One such use is for bicyclists to record altitude gained or lost during a bicycle trip. In particular, those who train and compete in bicycle races often wish to know the altitude gain or loss during a training ride. This helps provide an insight to the training regimen and whether it is correct for the event for which they are training.

Conventional accumulating altimeters can provide information regarding altitude gain or loss. For example, U.S. Pat. No. 4,694,694 discloses an altimeter which accumulates and displays total altitude gains or losses over a selected interval of time. If set to accumulate and display total gains in altitude, any and all altitude gains are accumulated and displayed.

However, such indiscriminate altitude accumulation may not be meaningful and can be misleading. During virtually any bicycle ride, slight undulations in terrain, including grade separations at railroads and highways, as well as transient barometric pressure variations can cause the altimeter to mistakenly detect that it has gained or lost altitude. This causes the accumulated altitude (gain or loss) to increase, although no net change has occurred. In other words, even though the instrument may have detected a number of altitude changes while traversing a number of rises or depressions in the roadway, such changes do not correctly represent the work or effort put forth by the rider.

For a cyclist, ascents and descents of grade separations are of no interest. If the accumulating altimeter accumulates all altitude gain or loss, however small, the cyclist will not receive meaningful information regarding the effort put forth, and therefore the training value of the ride.

Furthermore, the altimeter is subject to mechanical vibration and electrical noise within its own circuits. These also can cause the altimeter to accumulate further altitude gains or losses. The errors introduced from these effects can be substantial. For example, typical altitude measurement errors can be on the order of 10-20 feet due to mechanical vibration or electrical noise within the altimeter.

Therefore, it is desirable to have an accumulating altimeter which can selectively accumulate altitude changes such as gains, while selectively ignoring some, but not all, opposing altitude changes such as losses. In other words, it would be desirable to have an accumulating altimeter that can selectively ignore insignificant altitude changes, due to such things as mechanical vibration, slightly rolling terrain or highway overpasses, while at the same time being capable of recognizing significant altitude changes, due to such things as riding over a hill or into a valley.

SUMMARY OF THE INVENTION

An accumulating altimeter in accordance with the present invention has selective ascent and descent accumulation thresholds which allow it to initially ignore altitude gains or losses below predetermined amounts, while accounting for altitude gains and losses exceeding the predetermined amounts.

The present invention accepts a signal representing the present altitude. If the accumulator is enabled, it first determines whether the altitude has changed, and if so, whether the altitude change is in the direction of interest and is greater than or equal to a first accumulation threshold. If it is, the accumulator begins to accumulate altitude changes in the direction of interest.

However, if the altitude change opposes that which the accumulator is programmed to accumulate, e.g. the present altitude is decreasing when the accumulator is programmed to accumulate increases in altitude, one of two things happen. If the opposing change in altitude does not meet or exceed a second accumulation threshold, it will simply be used to offset non-opposing altitude changes, i.e. altitude changes in the direction of interest. On the other hand, if the opposing change in altitude does reach the second accumulation threshold, a new reference altitude is established and all further non-opposing changes in altitude will be accumulated, once they in turn meet or exceed the first accumulation threshold. The first and second accumulation thresholds can be different or equal, as desired.

Therefore, the present invention allows for selective accumulation of either gains or losses in altitude, while selectively accounting for opposing changes in altitude, thereby giving a more meaningful indication of total altitude gain or loss. In other words, non-opposing altitude changes are accumulated in accordance with a selectively preset first accumulation threshold, while opposing altitude changes are used in accordance with a selectively preset second accumulation threshold to selectively offset, resume or restart accumulation of non-opposing altitude changes.

These and other objectives, features and advantages of the present invention will be understood upon consideration of the following detailed description of the invention and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a functional block diagram of an accumulating altimeter in accordance with the present invention.

FIG. 2 is a graph illustrating exemplary altitude gains and losses over an arbitrary distance and the resulting accumulated altitude change with the present invention selectively set to accumulate altitude increases.

FIGS. 3A-3C are flow charts representing the operational steps of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, an accumulating altimeter 10 in accordance with the present invention includes a pressure sensor 12, an analog-to-digital converter 14, an accumulator 16, a display driver 18 and a display 20. The pressure sensor 12 can be of any type commonly used for altimeters. Preferably, a solid state pressure sensor, or transducer, such as an integrated circuit having piezoresistors implanted within the semiconductor material, is used for greater sensitivity and reliability.

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The pressure sensor 12 provides an analog signal 22 representing the present atmospheric pressure as measured by the pressure sensor 12. As is well known in the art, altitude is inversely proportional to atmospheric pressure. Therefore, the analog signal 22 provided by the pressure sensor 12 in accordance with the measured atmospheric pressure. This analog pressure signal 22 is received by the analog-to-digital converter 14 for conversion into an equivalent digital pressure signal 24 for use by the accumulator 16.

The accumulator 16 receives this digital pressure signal 24 and computes the altitude in accordance with well known mathematical formulas. The accumulator 16 then produces an accumulated altitude signal 26 for display, as discussed more fully below. The accumulator 16 also receives an accumulate enable signal 28 which selectively enables or disables the operation of the accumulator 16. For example, if the accumulating altimeter 10 were to be used on a bicycle (not shown), the accumulate enable signal 28 can originate from a speedometer (not shown), or from a sensor which senses rotation of one of the bicycle wheels (not shown), and be used to selectively enable the accumulator 16 only when the bicycle is in motion.

The accumulator 16 further receives an ascend/descend select signal 30 which tells the accumulator 16 whether to accumulate altitude gains or losses, as discussed more fully below. A related signal further received by the accumulator 16 is an accumulation threshold signal 32. This threshold signal 32, as discussed more fully below, tells the accumulator 16 when to begin accumulating altitude changes and when to establish reference altitudes.

The accumulated altitude signal 26 from the accumulator 16 is received by the display driver 18. A display signal 34 is then provided to a display 20, such as a liquid crystal display, for viewing by the user. For example, if used on a bicycle, the display 20 can be mounted upon the handlebars for easy viewing by the rider.

It will be recognized that various conventional pressure sensors, digital-to-analog converters, display drivers and displays exist and can be used in an altimeter 10 in accordance with the present invention. It will be further recognized that the accumulator 16 can consist of a number of conventional components. For example, the accumulator 16 can consist of a conventional microprocessor programmed to operate in accordance with the present invention. Alternatively, other conventional digital components, e.g. programmable logic arrays, can also be used.

Referring to FIG. 2, the operation of and more meaningful altitude accumulation provided by the present invention can be understood. In the graph of FIG. 2, the abscissa represents distance and the ordinate represents altitude in increments of 10 feet. The numbers following along the graph represent the accumulated non-opposing altitude changes, i.e. gains.

For this example in FIG. 2, the accumulator 16 has been set to accumulate altitude gains, and both the non-opposing and opposing accumulation thresholds are set at 30 feet. The accumulation thresholds preferably have nonzero values representing altitude changes of at least 20 feet. This has the advantageous effect of allowing the altimeter 10 to initially mask, or filter, out signals representing false altitude changes caused by mechanical vibration or electrical noise within the altimeter 10.

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However, it should be understood that the accumulation thresholds need not necessarily be limited to such values and can have any desired values. Further, the non-opposing and opposing accumulation thresholds can be different or equal, as desired.

At the beginning of a trip, i.e. at point A, the accumulate enable signal 28 is activated. As the user travels up a 10 foot rise to the first peak at point B, the display still indicates zero accumulated altitude gain since the non-opposing accumulation threshold has not yet been exceeded. As the user descends 20 feet to point C, a new reference altitude is generated for the accumulator 16. In other words, whereas the original reference altitude was zero at point A, the reference altitude is now that of point C, i.e. -10 feet.

As the user ascends 30 feet to point D, the display 20 now indicates an accumulated altitude gain of 30 feet, since the altitude gain has now reached the non-opposing accumulation threshold of 30 feet, relative to the latest reference altitude of -10 feet at point C. As the user continues to travel up the rise another 20 feet to the next peak at point E, the altitude gained continues to be accumulated, resulting in an accumulated altitude gain of 50 feet.

As the user descends 20 feet to point F, the accumulated altitude does not change since no further altitude gains have yet been made. Furthermore, since the descent is only 20 feet, i.e. less than the opposing accumulation threshold of 30 feet, a new reference altitude is not established at point F. This descent of less than the opposing accumulation threshold will be used to offset subsequent non-opposing altitude changes, i.e. altitude gains.

As the rider ascends to point G, this 20 foot gain is offset, or cancelled out, by the preceding descent of 20 feet between points E and F. As the user ascends 10 feet further to point H, an additional 10 feet of altitude gain is accumulated, i.e. 60 feet of altitude gain have now been accumulated and can be displayed.

Descending 40 feet to point I, the user has now descended in altitude sufficiently to meet the opposing accumulation threshold of 30 feet. Therefore, a new reference altitude is once again established, this time at +20 feet at point I. Hence, just as in the beginning of the trip at point A, no further gains in altitude will be accumulated until the non-opposing accumulation threshold has been met.

As the user ascends 30 feet to point J, i.e. at +50 feet, the non-opposing accumulation threshold of 30 feet has again been met and is therefore added to the previous accumulated altitude gain of 60 feet, resulting in an accumulated altitude gain of 90 feet. As the user continues to ascend to point K, this further altitude gain of 40 feet is also accumulated, resulting in a total altitude gain accumulation of 130 feet.

Thus, as can be seen from the graph of FIG. 2, only altitude gains which follow those substantial enough to reach the non-opposing accumulation threshold are accumulated. Until the non-opposing accumulation threshold has been reached, minor descents and ascents, such as those occurring about the depressions at points C and F, are not accumulated and allowed to distort the altitude gain accumulation.

Referring to FIGS. 3A-3C, the operational steps performed by an accumulator 16 in accordance with the present invention can be understood. The first step 100 is to install the battery which powers the altimeter 10. Upon receipt of battery power, the first step 102 per-

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formed by the accumulator 16 is to set an internal variable "total climb" to zero. This variable will be used to represent all altitude changes accumulated by the altimeter 10.

The next step 104 is the turning on of the altimeter 10 by the user. The accumulator 16 then performs the step 106 of setting another internal variable "climb" to zero. This variable will be used to represent all altitude changes accumulated during a trip. It should be understood that use of the term "climb" is not to imply that only gains in altitude are to be accumulated. In other words, the "climb" or "total climb" accumulated selectively represents accumulated altitude changes, i.e. either gains or losses in altitude.

The next step 108 performed is initialization. A "descent flag" is set initially, as a default condition. A "reference" variable is initially set equal to the present altitude which is computed based upon the atmospheric pressure signal received from the pressure sensor 12 via the analog-to-digital converter 14, as discussed above. Following this, the steps 110, 112 of computing the present altitude and determining whether the accumulator 16 is enabled are performed. If the accumulator 16 is not enabled, an operational loop is entered and the preceding steps 108, 110, 112 are repeated until the accumulate enable signal 28 has been activated.

Once the accumulator 16 has been enabled, the next step 114 is to compute the change, if any, in altitude. The difference in altitude "dA" is computed by subtracting the reference altitude from the present measured altitude.

Following this, the next step 116 is to check whether ascents or descents are to be accumulated. If descents are to be accumulated, the next step 118 is to "invert," i.e. multiply by -1 , the altitude change dA.

Following this "inversion" of the computed altitude change dA, or if operation is set in the ascend accumulate mode, the next step 120 is to check whether the descent flag has been set. Initially, as discussed above for the initialization step 108, the descent flag is set. In this case, and whenever the descent flag is set otherwise, the operation continues as discussed below for FIG. 3B. If the descent flag is not set, the operation continues as discussed below for FIG. 3C.

Referring to FIG. 3B, the first step 122 performed if the descent flag is set is to determine whether the altitude change is less than zero, i.e. negative. If the altitude change is negative, i.e. indicating a descent, the next step 124 is to set the reference altitude equal to the present altitude. Following that, operation resumes with the step 110 of recomputing the present altitude, as discussed above for FIG. 3A.

If the altitude change is not less than zero, the next step 126 is to determine whether the altitude change is greater than or equal to the non-opposing accumulation threshold. If it does not yet meet or exceed the non-opposing accumulation threshold, operation resumes with the step 110 of recomputing the present altitude, as discussed above for FIG. 3A.

If the altitude change does meet or exceed the non-opposing accumulation threshold, the next two steps 128, 130 update the climb and total climb variables by adding the value of the non-opposing accumulation threshold to each. Following that, the next steps 132, 124 are to reset the descent flag and set the reference altitude equal to the present altitude. Operation then resumes with the step 110 of recomputing the present altitude, as discussed above for FIG. 3A.

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It should be understood that the steps 128, 130 of incrementing the climb and total climb variables by the value of the non-opposing accumulation threshold, along with the step 124 of resetting the reference altitude variable equal to the present altitude, represent merely one way of accumulating altitude changes in accordance with the present invention. In other words, this "ratcheting" of the reference altitude variable is simply one way to accumulate altitude changes. For example, the reference altitude variable can be set initially, and reset only after opposing altitude changes reaching the opposing accumulation threshold have been measured (per discussion above for FIG. 2), with non-opposing altitude changes accumulated as they are measured (similar to steps 136, 138 discussed below).

Referring to FIG. 3C, if the descent flag is set (discussed above for FIG. 3A), the next step 134 is to determine whether the altitude change is greater than or equal to zero, i.e. positive. If the altitude change is positive, thereby indicating an altitude gain, the next steps 136, 138 are to update the values of the climb and total climb variables by adding the amount of the altitude change to each. Following that, the next step 140 is to set the reference altitude equal to the present altitude, and then resume operation with the step 110 of recomputing the present altitude, as discussed above for FIG. 3A.

If the altitude change is not greater than or equal to zero, the next step 142 is to determine whether the altitude change is less than or equal to the "inverted" value of the opposing accumulation threshold, i.e. the opposing accumulation threshold value multiplied by -1 . If it is not, operation resumes with the step 110 of recomputing the present altitude, as discussed above for FIG. 3A.

If the altitude change is less than or equal to the inverted value of the opposing accumulation threshold, the next step 144 is to set the descent flag once again, followed by the step 140 of setting the reference altitude equal to the present altitude. Following that, operation resumes with the step 110 of recomputing the present altitude, as discussed above for FIG. 3A.

As discussed above, the steps 136, 138 of incrementing the climb and total climb variables by the value of the altitude difference dA, along with the step 140 of resetting the reference altitude variable equal to the present altitude, represent merely one way of accumulating altitude changes in accordance with the present invention. This "ratcheting" of the reference altitude variable is simply one way to accumulate altitude changes. For example, the reference altitude variable can be set initially, and reset only after opposing altitude changes reaching the opposing accumulation threshold have been measured (per discussion above for FIG. 2), with non-opposing altitude changes accumulated as they are measured.

It should be understood that the altitude accumulation performed by the present invention is not limited to only altitude gains or only altitude losses. In other words, an altitude accumulator in accordance with the present invention can accumulate altitude changes in either direction. Furthermore, the present invention can be configured to accumulate altitude changes in both directions simultaneously and independently.

It should be further understood that the particular language used in the foregoing discussion and in the flow charts of FIGS. 3A-3C was selected as a matter of convenience for a preferred embodiment in which alti-

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tude gains are to be accumulated. However, altitude losses can be accumulated equally well, with the term "climb" representing altitude loss rather than gain, and the arbitrarily named "descent" flag corresponding to altitude gain rather than loss. Furthermore, the non-opposing and opposing accumulation thresholds can be independently selected for any desired altitude changes.

Various alternatives to the embodiments of the present invention described herein can be employed in practicing the present invention. It is intended that the following claims define the scope of the present invention, and that structures and methods within the scope of these claims and their equivalents be covered thereby.

What is claimed is:

1. An altitude accumulator for selectively accumulating altitude changes, comprising:

receiver means for receiving a pressure signal representing atmospheric pressure;

computer means for computing altitude based upon said received pressure signal; and

accumulator means for selectively accumulating and providing an accumulated altitude signal representing accumulated altitude changes which reach a first accumulation threshold in a first direction from a reference altitude, said altitude changes being based upon said computed altitude, wherein altitude changes in a second direction which do not reach a second accumulation threshold offset subsequent altitude changes in said first direction, and further wherein altitude changes in said second direction which do reach said second accumulation threshold cause said reference altitude to change in accordance therewith.

2. An altitude accumulator as recited in claim 1, wherein said first and second directions comprise altitude increases and decreases, respectively.

3. An altitude accumulator as recited in claim 1, wherein said first and second directions comprise altitude decreases and increases, respectively.

4. An altitude accumulator as recited in claim 1, wherein said first accumulation threshold is programmable.

5. An altitude accumulator as recited in claim 1, wherein said second accumulation threshold is programmable.

6. An altitude accumulator as recited in claim 1, wherein said first and second accumulation thresholds are equal.

7. An altitude accumulator as recited in claim 1, wherein said first accumulation threshold has a nonzero value.

8. An altitude accumulator as recited in claim 1, wherein said second accumulation threshold has a nonzero value.

9. An accumulating altimeter for selectively accumulating altitude changes, comprising:

pressure sensor means for sensing atmospheric pressure and providing a pressure signal proportional thereto;

computer means for receiving said pressure signal and computing altitude based thereon, and further for selectively accumulating and providing an accumulated altitude signal representing accumulated altitude changes which reach a first accumulation threshold in a first direction from a reference altitude, said altitude changes being based upon said computed altitude, wherein altitude changes in a second direction which do not reach a second accumulation threshold offset subsequent altitude changes in said first direction, and further wherein altitude changes in said second direction which do reach said second accumulation threshold cause

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said reference altitude to change in accordance therewith; and

display means for receiving said accumulated altitude signal and for displaying said accumulated altitude changes.

10. An altitude accumulator as recited in claim 9, wherein said first and second directions comprise altitude increases and decreases, respectively.

11. An altitude accumulator as recited in claim 9, wherein said first and second directions comprise altitude decreases and increases, respectively.

12. An altitude accumulator as recited in claim 9, wherein said first accumulation threshold is programmable.

13. An altitude accumulator as recited in claim 9, wherein said second accumulation threshold is programmable.

14. An altitude accumulator as recited in claim 9, wherein said first and second accumulation thresholds are equal.

15. An altitude accumulator as recited in claim 9, wherein said first accumulation threshold has a nonzero value.

16. An altitude accumulator as recited in claim 9, wherein said second accumulation threshold has a nonzero value.

17. A method for selectively accumulating altitude changes, comprising the steps of:

receiving a pressure signal which is proportional to atmospheric pressure;

computing altitude based upon said received pressure signal;

selectively accumulating altitude changes which reach a first accumulation threshold in a first direction from a reference altitude, wherein altitude changes in a second direction which do not reach a second accumulation threshold offset subsequent altitude changes in said first direction, and further wherein altitude changes in said second direction which do reach said second accumulation threshold cause said reference altitude to change in accordance therewith; and

providing an accumulated altitude signal representing said accumulated altitude changes.

18. A method as recited in claim 17 further comprising the step of selecting said first and second accumulation thresholds.

19. A method for measuring and selectively accumulating altitude changes, comprising the steps of:

measuring atmospheric pressure and providing a pressure signal proportional thereto;

computing a reference altitude based upon said pressure signal;

computing present altitude based upon said pressure signal;

selectively accumulating altitude changes which reach a first accumulation threshold in a first direction from said reference altitude;

offsetting subsequent altitude changes in said first direction with altitude changes in a second direction which do not reach a second accumulation threshold;

changing said reference altitude in accordance with altitude changes in said second direction which do reach said second accumulation threshold; and providing an accumulated altitude signal representing said accumulated altitude changes.

20. A method as recited in claim 19 further comprising the step of selecting said first and second accumulation thresholds.

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